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(56) Documents Cited
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(54) Abstract Title
Breathing simulator

(57) Computer 3 controls pump 1 according to a stored breathing pattern of a patient to produce an output at connector 2, eg for testing therapeutic nebulizers. Many patterns may be stored in the computer or be transmitted from data transmission means 4. Using input device 2 which includes a pressure transducer, a patient can record breathing patterns for subsequent use.
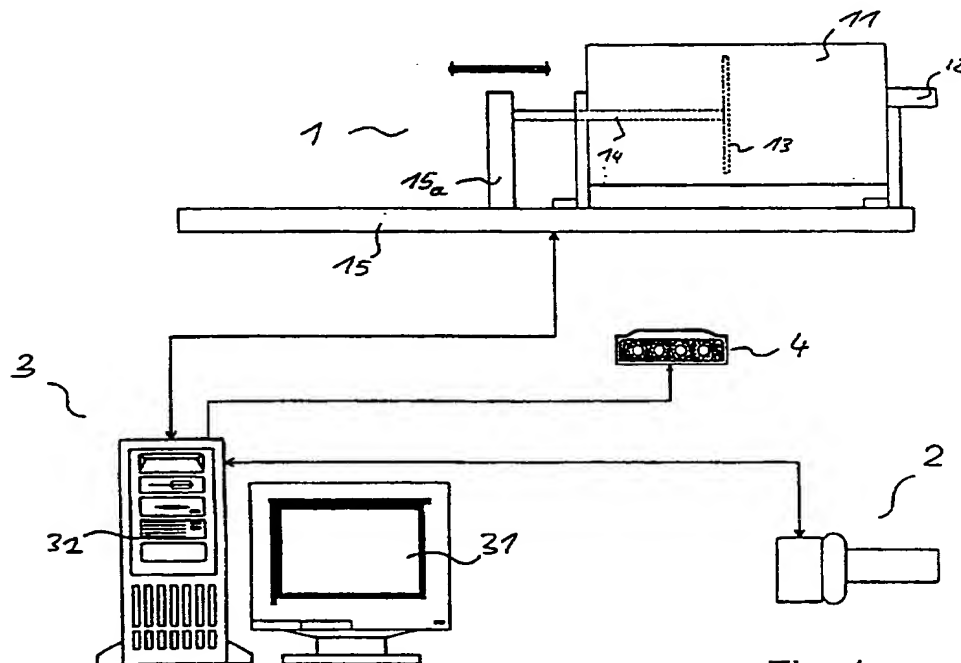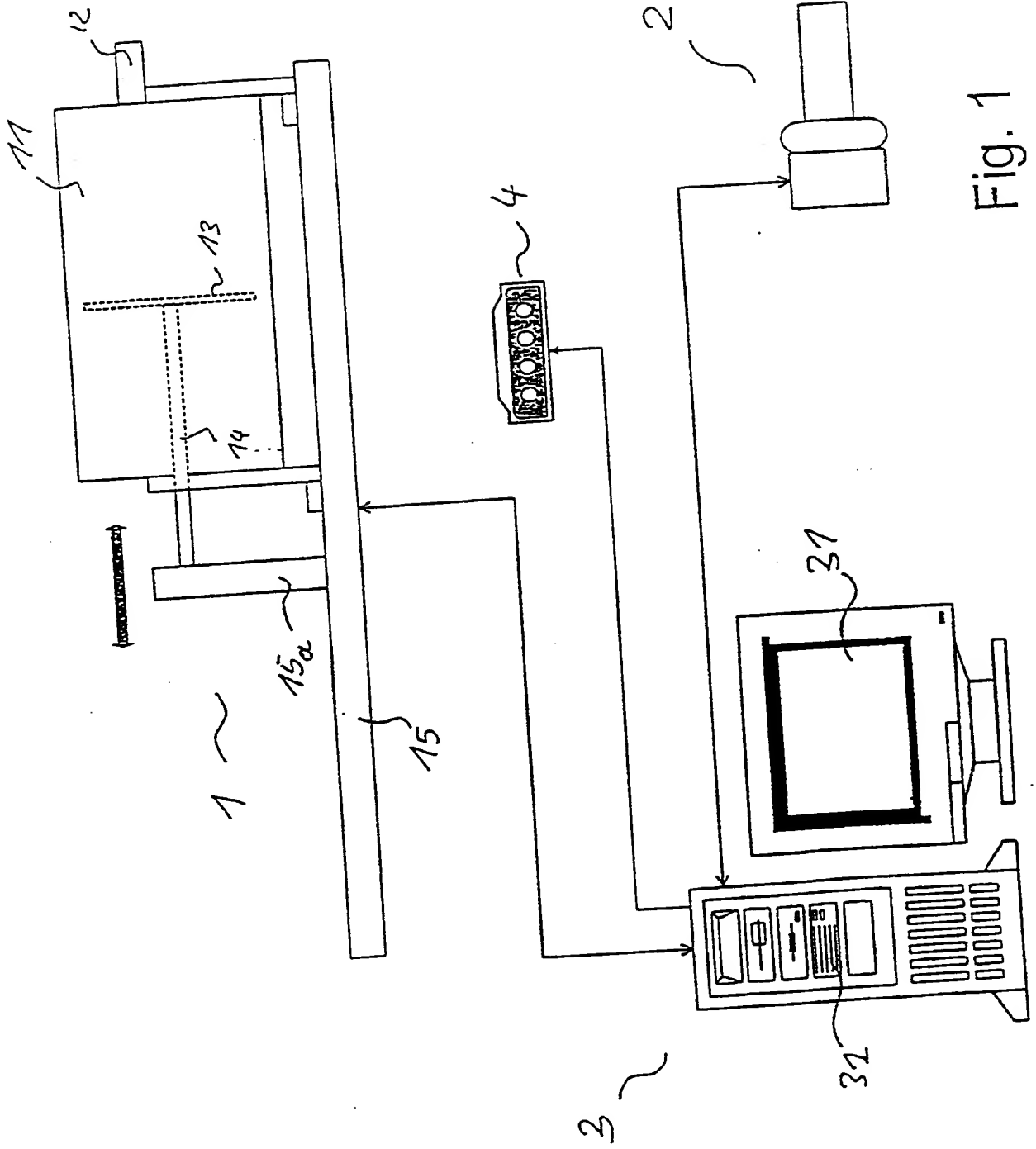
Fig. 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

Fig. 1

BREATH SIMULATOR

The invention relates to a breath simulator, i.e. a system for simulation (and recording) of breathing patterns of healthy and sick persons.

During the development of effective therapeutical nebulisers, changes in construction must always be examined with respect to the manner and the degree in which the nebuliser performance is influenced. The nebuliser performance of a therapeutical nebuliser is judged on the basis of a plurality of criteria, including amongst others the amount of aerosol and the droplet spectrum. These two values are in direct correlation with the breathing behaviour of the patient, who breathes differently dependent on the nature and gravity of his disease. The breathing behaviour also differs from patient to patient and clearly differs in the comparison between healthy and sick persons. Until now these differences have only been considered insufficiently in the examination methods and test procedures used for therapeutical nebulisers.

In view of this situation, the object of the invention is to be seen in providing the basis for a reliable, experimental examination of therapeutical nebulisers.

The object is solved by a breath simulator for the simulation of breathing patterns with the features shown in patent claim 1.

The breath simulator according to the invention leads to the decisive advantage that by covering large groups of both healthy and sick people, a reliable basis is established on the foundation of which examinations can be carried out on therapeutical nebulisers with a reliability not yet achieved.

Moreover, a breath simulator is provided by the invention which permits a simulation of breathing patterns with a high accuracy of reproduction.

The invention is described in the following in more detail on the basis of an embodiment and with reference to the drawing, which shows:

Fig. 1 a schematic representation of the construction of an embodiment of a breath simulator according to the invention.

The embodiment of the invention shown in fig. 1 comprises a pump means 1, a recording means 2 and a computer means 3 which is connected both with the pump means 1 and with the recording means 2. The computer means 3 controls the pump means 1 and evaluates output signals of the recording means 2. By evaluation of the output signals of the recording means 2, a breathing pattern is detected. By activation of the pump means 1, a breathing pattern is simulated.

However, the computer means can also be constructed so as to be separate for the pump means and the recording means, so that the recording of a breathing pattern can take place independent of the simulation. In this respect, the computer means and the recording means can be very compact, so that this unit is also suitable for mobile use. The data are then transmitted in a computer means connected with the pump means, for which suitable interfaces are provided. The transmission of the data can, however, also take place with the aid of a data carrier, for example a RAM card or a diskette.

In the embodiment shown in Fig. 1, the pump means 1 consists of a hollow cylinder 11 with a connecting piece 12, to which the therapeutical nebuliser (not shown) which is to be examined can be connected. In the hollow cylinder 11 of the pump means 1, there is a piston 13 with piston rod 14, which extends out of the hollow cylinder 11. The hollow cylinder is secured to a linear drive unit 15, the moved part 15a of which is secured to the piston rod 14, so that the piston rod 14 together with the piston 13 can be reciprocated in the hollow cylinder 11. The linear drive unit 15 can be activated in such a manner that the breathing pattern of a patient is simulated on the connecting piece 12 of the pump means 1. In addition, other breathing patterns can also be simulated.

The activation of the linear drive unit 15 takes place by the computer means 3, which can be a customary personal computer with suitable activation interface which is adapted to the linear drive unit 15. The customarily provided serial interfaces of the

personal computer can be used as interface. The signals transmitted via the interface lead to the fact that the linear drive unit 15 moves the piston 13 in the hollow cylinder 11 of the pump means with a predetermined speed in one of the two directions and thus generates an under- or over-pressure on the connecting piece 12. The activation can take place in such a manner that the speed with which the linear drive unit 15 moves the piston 13 reproduces the breathing behaviour of a patient with great accuracy, so that the pump means 1 simulates the breathing pattern of a patient on the connecting piece 12. The computer means 3 thus assumes the task of a control means for the linear drive unit 15.

The computer means 3 reverts in this respect to a stored breathing pattern, wherein for example, it is a case of a number of value triples (DIRECTION,SPEED.TIME). The value DIRECTION shows in what direction the piston 13 of the pump means 1 is to be moved, i.e. whether on the connecting piece 12 of the pump means 1 a pressure increase or decrease should be produced. The value SPEED shows with what increase the movement of the piston should take. The value TIME shows for what period of time the change in pressure takes place. By a plurality of value triples, the breathing pattern of an arbitrary patient can be reproduced with high accuracy on the connecting piece of the pump means 1.

The computer means permits the user to select a (previously stored) breathing pattern via a display 31. The breathing patterns are deposited in this respect inside a breathing pattern library in certain categories or classes, from which the user selects the breathing pattern desired for the examination of the therapeutical nebuliser. The computer means 3 additionally offers the possibility of choosing a breathing pattern which is typical for a category or class which is obtained for example from the average of a plurality of breathing patterns which were recorded individually for individual patents with the same syndromes.

The recording of breathing patterns takes place with the aid of the recording means 2, which consists of a mouthpiece 21, a filter 22 and a sensor 23. As sensor 23 a pressure difference sensor can be used which detects via a pressure difference the flow

of breath of the patient, who breathes in and out via the mouthpiece 21 of the recording means 2. The recording means 2 is connected with the computer means 3, so that the respiratory flow measured values of the sensor 23 are received by the computer means 3 and evaluated . The computer means 3 stores the respiratory flow measured values in a memory means 32 in a form which permits that on the basis of the stored measured values the above-described value triples, or a different measured value representation, are formed, with which the breathing behaviour of the patient, which was recorded with the aid of the recording means 2, can be simulated by activation of the pump means 1.

The data is preferably stored in such a manner that the computer means 3 builds up a breathing pattern library covering the breathing pattern of a large number of persons. Within the library, the breathing patterns are catalogued or typified, so that predetermined categories or classes are combined. Within the categories or classes, typical breathing patterns are selected or produced which are characteristic for the category or class.

In order to be able to carry out the evaluation by the computer means 3, and thus the test of a therapeutical nebuliser, on the basis of a large number of breathing patterns, the computer means 3 is connected in an advantageous configuration with a data transmission means 4. With the aid of the data transmission means 4, the computer means 3 can be connected with other computer means according to the invention or with specific data banks, in order to exchange the data of breathing patterns, for example the above-described value triples. In this manner, a breathing pattern library which is as representative as possible can be very rapidly formed.

CLAIMS

1.   A breath simulator for the simulation of the respiration of a patient for the examination of therapeutical nebulisers, comprising

a pump means (1), having a connecting piece (12) for connection of a therapeutical nebuliser, and

a computer means (3), which activates the pump means in such a manner that the stored breathing pattern of a patient is produced on the connecting piece.

2.   A breath simulator according to claim 1, characterised in that the stored breathing pattern is stored in the form of measured values of a breathing pattern of a patient.

3.   A breath simulator according to claims 1 or 2, characterised in that the computer means (3) comprises a memory unit (33) in which a plurality of stored breathing patterns are stored.

4.   A breath simulator according to one of the claims 1 to 3, characterised in that the stored breathing patterns are combined into classes according to predetermined criteria and a breathing pattern typical for a class of breathing patterns is respectively stored.

5.   A breath simulator according to one of the claims 1 to 4, characterised in that the computer means (3) is connected with a data transmission means (4) for the transmission of breathing patterns.

6.   A breath simulator according to claim 5, characterised in that the computer means (3) is connected via the data transmission means (4) with the computer means of a further breath simulator.

7.   A breath simulator according to one of the claims 1 to 6, characterised in that for the recording of a breathing pattern of a patient, a recording means (2) is provided, which is connected with the computer means and the recording signals of which can be evaluated by the computer means and stored as breathing pattern.

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8.   A breath simulator according to claim 7, characterised in that the recording means (2) comprises a mouthpiece (21) for the patient and a sensor (22), preferably a pressure difference sensor.

9.   A recording means for breathing patterns for the simulation of a patient's breathing for the examination of therapeutical nebulisers with the aid of a breathing simulator according to one of the claims 1 to 6, comprising

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a recording means (2) for recording a breathing pattern of a patient,
and
a computer means (3), which is connected with the recording means and which evaluates the recording signals of the recording means and stores same as breathing pattern.

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10.   A breath simulator according to claim 9, characterised in that the recording means (2) comprises a mouthpiece (21) for the patient and a sensor (22), preferably a pressure difference sensor.

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Claims searched: 1-8	**Date of search:**	13 August 1998

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Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): G3N (NGA5, NGF, NGF2)

Int Cl (Ed.6): A62B 27/00, G09B 23/28, 23/30, 23/32

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	EP 0570015 A1 (3M) note column 4 line 44 to column 5, line 8 and column 8 line 44 to column 9, line 15	1-8
A	WO 97/12351 A1 (IHC Health Services Inc.)	-
X	US 4796467 (Biosystems Inc.) See column 7, line 65 to column 8 line 17	1-6

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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